Brane-world inflation without inflaton on the brane

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I. MOTIVATION

It is now widely accepted that our spacetime is not 4-dimensional but higher dimensional from the unified theoretical point of view. In [1], Randall and Sundrum found an interesting Z_2-symmetric solution of the 5-dimensional Einstein equations with a negative cosmological constant. In this solution, two boundary branes with positive and negative tensions are embedded in the 5-dimensional anti-de Sitter (AdS) space and the tensions of the branes are chosen so that the effective cosmological constant on the branes vanishes and the 4-dimensional Minkowski space is realized on the branes. Furthermore, from the unified theoretic point of view, the gravitational action is not necessarily the Einstein-Hilbert action. In fact, string theory tells us that the dimensionally reduced effective action includes not only higher-order curvature terms but also dilatonic gravitational scalar fields. Thus at the level of the "low-energy" 5-dimensional theory, it is naturally expected that there appears a dilaton-like scalar field in addition to the Einstein-Hilbert action. Thus it is of interest to investigate how such a scalar field in the 5-dimensional theory affects the brane-world.

In this talk [2], Inspired by the Randall-Sundrum brane-world scenario, we investigate the possibility of brane-world inflation driven not by an inflaton field on the brane, but by a bulk, dilaton-like gravitational field.

II. MODEL

As a toy model for the dilaton-like gravitational field, we consider a minimally coupled massive scalar field in the bulk 5-dimensional spacetime, and look for a perturbative solution in the anti-de Sitter (AdS) background.

We assume that the 5-d cosmological constant Λ_5 and the brane tension are determined from some yet unknown unified theory. However, due to dynamics of the bulk gravitational field, the dilaton-like scalar field with an effective potential $V(\phi)$ appears in the bulk. We assume $V > 0$ which may vary very slowly in space and time. Then, inflation occurs on the brane. As the universe evolves, the potential V decreases and eventually becomes zero (or very small) and the standard Friedmann universe is recovered in the low energy limit.

III. SUMMARY

We have found that the standard slow-roll inflation can occur if the bulk scalar field is sufficiently slowly varying both in space and time near the brane. The solution we have obtained gives slow-roll inflation on the brane and is found to be unique, provided that $|m^2|/H^2 \ll 1$, which is the same condition for slow-roll inflation as in the usual 4-dimensional theory.

Reference

[1] L. Randall and R. Sundrum, Phys. Rev. Lett. **83**, 3370 (1999); Phys. Rev. Lett. **83**, 4690 (1999).
[2] Y. Himemoto and M. Sasaki, Phys. Rev. D**63**, 044015 (2001).

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